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J. Michael Neary
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Sept. 30, 2004
Date

Inventor: Gerald J. Julien)
)Group Art Unit: 3726
Serial No.: 10/069,384)
)Examiner: Eric Compton
Filed: Feb. 19, 2002)
)
Title: "Nitinol Bearings"

Corrected Brief on Appeal

Sept 16, 2004

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

This Brief on Appeal is being submitted in furtherance of Applicant's appeal from the final rejection of claims 1-10 and 12-20 in the Final Office Action dated January 30, 2004, after correction pursuant to the Notification of Non-Compliance dated Aug. 31, 2004.

1) Real party in interest

Nitinol Technologies, Inc., assignee of this Application, is the real party in interest.

2) Related Appeals and Interferences

Applicant knows of no related interferences or appeals that would directly affect or be directly affected by or have a bearing on the Board's decision in this pending appeal.

3) Status of Claims

Claims 1-10 and 12-20 were rejected in the Final Office Action as noted in summary fashion below. Claim 11 was objected to. No claims were allowed. Claims 1-8 were canceled in a R116 amendment.

A. Claim 9 was rejected under 35 USC 103 as unpatentable over P/N 5,843,152 to Tu et al.

B. Claim 10 was rejected under 35 USC 103 as unpatentable over P/N 4,561,272 to Goldstein.

C. Claim 20 was rejected under 35 USC 103 as unpatentable over P/N 4,324,441 to Rouverol et al.

D-G. Claims 1-8 were rejected under 35 USC 103 as unpatentable over Rouverol in view of P/N 3,283,376 to Hockin and P/N 3,422,663 to James et al. and others. These claims were canceled in the R116 amendment, so these issues are now moot.

H. Claims 12-15 and 17 were rejected under 35 USC 103 as unpatentable over Rouverol in view of P/N 4,216,629 to Degaeta.

I. Claim 16 was rejected under 35 USC 103 as unpatentable over Rouverol/ Degaeta in view of P/N 4,724,297 to Nielsen.

J. Claim 18 was rejected under 35 USC 103 as unpatentable over Rouverol in view of P/N 1,472,922 to Lothrop.

K. Claim 19 was rejected under 35 USC 103 as unpatentable over Rouverol/ Sommer et al in view of P/N 4,023,988 to Stickels et al.

4) Status of Amendments

On June 30, 2004, (concurrently with the Appeal Brief) Applicant filed a R116 Amendment canceling claims 1-8, rewriting claims 9-12, 17, and 20, and adding new claim 21. The Examiner entered this R116 Amendment, thus the Appeal Brief filed on June 30, 2004 is being revised as this Corrected Appeal Brief to reflect the current version of the claims.

5) Summary of the Invention

A bearing having bearing elements made of Type 60 Nitinol made by an investment casting process for producing near net shape parts of Nitinol includes making a ceramic mold having a series of spherical cavities, pouring molten Nitinol into the mold cavities, cooling the mold and the Nitinol in the cavities to produce solidified Nitinol balls, and breaking the mold away from the Nitinol balls. Nitinol rods for roller bearings can be made by conventional casting directly from the crucible in a draw-down oven. The bars are hot machined or hot rotary swaged and then centerless ground and laser cut to length, or are first cut to length and then centerless ground individually for crowned roller elements. The balls are broken or cut from the risers, leaving the gates attached, and are consolidated by heating under pressure in a hot isostatic press, then ground to the desired size. The balls or rollers are polished, then treated to create an integral ceramic finish. They are then repolished to produce an extremely smooth finish. The balls can also be cut from a sheet or plate of the ball material as cubes or cylinders and processed in an abrasive tumbler to round off the corners and edges, and the rounded cubes or cylinders can then be ground to spherical form in a conventional ball grinder.

6) Issues

A. Whether the rejection of claim 9 under 35 USC 103 as unpatentable over P/N 5,843,152 to Tu et al. was proper.

B. Whether the rejection of claim 10 under 35 USC 103 as unpatentable over P/N 4,561,272 to Goldstein was proper.

C. Whether the rejection of claim 20 under 35 USC 103 as unpatentable over P/N 4,324,441 to Rouverol et al. was proper.

D-G. Claims 1-8 have been canceled in the R116 amendment, so there is no longer an issue regarding the rejection of these claims.

H. Whether the rejection of claims 12-15 and 17 under 35 USC 103 as unpatentable over Rouverol in view of P/N 4,216,629 to Degaeta was proper.

I. Whether the rejection of claim 16 under 35 USC 103 as unpatentable over Rouverol/ Degaeta in view of P/N 4,724,297 to Nielsen was proper.

J. Whether the rejection of claim 18 under 35 USC 103 as unpatentable over Rouverol in view of P/N 1,472,922 to Lothrop was proper.

K. Whether the rejection of claim 19 under 35 USC 103 as unpatentable over Rouverol/ Sommer et al in view of P/N 4,023,988 to Stickels et al. was proper.

7) Grouping of Claims

The rejected claims do not stand or fall together; that is, claims 9-10 and 12-20 are separately patentable, as explained in detail in the following Argument.

8) Argument

For simplicity of relating the summary Status of the Claims in §3 and the Statement of Issues in §6 with the related argument in this §8, the same letters used in §§3 and 6 will identify the argument sections.

A) Claim 9 was rejected under 35 USC 103 as unpatentable over P/N 5,843,152 to Tu et al. Tu discloses a medical instrument having a ball electrode 14 made of gold, platinum, silver, platinum, stainless steel, or Nitinol. Claim 9 was amended in the R116 amendment to more clearly define the claimed article as a ball bearing rather than as a Nitinol ball bearing element for use in a ball bearing, so the issue of refusing to give patentable weight to a limitation, on the ground that it is merely an “intended use”, because the limitation is in the preamble rather than the body of the claim no longer exists.

Tu does not teach a ball bearing, nor the use of his ball electrode as a rolling element for a ball bearing, and Applicant does not believe that there is anything in any cited reference that would lead a person of ordinary skill in the art to use Tu’s ball for that purpose. Moreover, Tu does not disclose a ball of Type 60 Nitinol, and there is nothing in Tu that would lead a person of ordinary skill in the bearing art or the medical instrument art to use Type 60 Nitinol instead of the usual Type 55 Nitinol (used in medical instruments and orthodontia because of its body-compatibility). Type 60 Nitinol is much more difficult to form and machine than Type 55 Nitinol, so there would always be an incentive to use Type 55 Nitinol rather than the claimed Type 60 Nitinol. Accordingly, Applicant believes that claim 9 is allowable as amended.

B. Claim 10 has been rejected under 35 USC 103 as obvious over Goldstein. Goldstein discloses a lock shackle having a Nitinol rod 10 in the center of the composite shackle. Claim 10 has been amended to more clearly define the claimed article for use in a roller bearing. Goldstein does not teach the use of his lock shackle rod as a rolling element for a roller bearing, and Applicant does not believe that there is anything in any cited reference that would lead a person of ordinary skill in the art to use Goldstein’s rod for that purpose. Moreover, Goldstein’s rod is made of Type 55 Nitinol, not Type 60 Nitinol as claimed. Type 55 rod and wire are

commercially available because Type 55 Nitinol is ductile enough to be drawn into wire and rod. Type 60 Nitinol, on the other hand, is not available commercially because it is so difficult to form that nobody has been able to develop a process for drawing Type 60 Nitinol. Therefore, since Goldstein does not teach Type 60 Nitinol for use in his lock shackle, and since Type 60 rod is not available commercially for use for bearing elements (or any other purpose), it would not be obvious to a person of ordinary skill in the art to use Type 60 Nitinol rod in a rolling element bearing. Accordingly, Applicant believes that claim 10 is allowable as presented.

Applicants regard as their invention.

C. Claim 20 has been rejected under 35 USC 103 as obvious over Rouverol. Rouverol teaches a rolling contact element for bearings or traction friction drive devices. The essence of Rouverol's teaching is the use of precompression of the rolling contact surface. He does mention in passing that shape memory materials are well suited to shrink-fit assemblies, and that the disadvantage of non-hardenability of nickel-titanium materials can be overcome by his prestressing techniques, which he discloses in great detail. In fact, Applicant has found that Type 60 Nitinol makes excellent bearing materials without prestressing. Applicant has attempted to claim this distinction in amended claim 20.

The Examiner asserts that the use of Type 60 Nitinol would have been obvious to one of ordinary skill in the bearing art because "it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice." Applicant denies that the use of Type 60 Nitinol would have been obvious to a person of ordinary skill in the art. It is so difficult to work and machine and grind that there is almost no use made of this material at present, and at the time of this invention, there was no other use made of this material other than the use by Applicant. Because of Applicant's developments, Type 60 Nitinol is beginning to be recognized as a material with attractive properties, but at the time this invention was made, there was no use made of this material at all and it was not commercially available. Indeed, Applicant had to teach the foundry how to make Type 60 Nitinol so that he could acquire enough stock

to conduct his development activities. Therefore, the *In re Leshin* decision is not applicable to the situation in which the suitability of the material is off-set by its well-known disadvantages and commercial unavailability because of those known disadvantages.

The Examiner cites Ex parte Masham for the proposition that "the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations." Applicant asserts that Ex parte Masham is inapposite because Rouverol does not teach an annular ring of Type 60 Nitinol, and specifically teaches away from Applicant's claimed limitation that the annular ring of Type 60 Nitinol is free of substantial compressive prestress. In any case, claim 20 has been amended to claim a bearing rather than a bearing race for use in a bearing, so the Ex parte Masham issue no longer exists. Clearly, the elements claimed in the bearing structure defined in claim 20 do not exist in Rouverol, and Rouverol does not have a teaching that would make obvious the combination defined in this claim. Therefore, Applicant believes that claim 20 is patentable over Rouverol.

H. Claims 12-15 and 17 were rejected under 35 USC 103 as unpatentable over Rouverol in view of P/N 4,216,629 to Degaeta.

Claim 12, amended in the R116 amendment, defines a process for making balls out of Type 60 material, which is so difficult to form into a ball that never before in history has it ever been formed into a ball. A sheet or plate of the Type 60 Nitinol material from which the ball is to be made is selected and ball blanks are cut out of the sheet. Those ball blanks are ground in a ball grinder to a desired spherical shape and size.

Degaeta teaches a process of producing generally spherical balls suitable for finish grinding in a ball grinding machine. Cylindrical blanks are cut from steel wire, such as 440C stainless steel, and are processed in Degaeta's apparatus to round off the corners or edges to produce ball blanks that are spherical enough to be ground to finished shape in a ball grinder. After rounding off the corners, the ball blanks are heat treated to full hardness before finish grinding in the ball grinder.

Degaeta also teaches the use of cubical blanks of “glass, ruby, silicon nitride, and other materials which by reason of being frangible could not be shaped by the “flashing operation heretofore applied to soft metal slugs.” He does not teach that blanks could be cut from a sheet of material.

The Examiner asserts that it would be obvious to a skilled artisan to cut cubical blanks out of a sheet of material having the desired cross-section to reduce waste. In fact, cutting the blanks from wire or rod involves the least possible waste. Cutting the blanks out of a sheet wastes the material that is removed in the kerf. Therefore, the motivation cited by the Examiner for his proposed modification of Degaeta does not exist and indeed is a disincentive for making the proposed modification. Moreover, the cutting of blanks out of a sheet of material is much slower and more costly than the fast and cheap process of feeding wire into a chopper and chopping the ends of the wire off in a rotary chopper. Therefore, even if there were some teaching that would lead a person of ordinary skill in the art to consider cutting blanks out of a sheet of material (and there is no such teaching in Applicant’s knowledge), the person of ordinary skill in the art would immediately discard the idea as inferior to the standard process because, compared to the standard process, it is slow, costly, inefficient and wasteful of material. Accordingly, Applicant believes that claim 12 is patentable over the combination of Rouverol and Degaeta.

Claim 13 specifies that the blanks are cubical in shape. Degaeta does mention cubical blanks of “glass, ruby, silicon nitride, and other materials which by reason of being frangible could not be shaped by the “flashing operation heretofore applied to soft metal slugs.” Nitinol is not frangible, so the cubical form taught by Degaeta does not apply, according to his own criterion for using the cubical shape for the blanks. Moreover, the cubical blanks of glass, ruby, silicon nitride, etc. are not disclosed as cut out of a sheet of material. That would be an insanely slow and costly way to make cubes, if it were possible at all. Accordingly, claim 13 is independently patentable over Rouverol and Degaeta.

Claim 14 specifies that the ball blanks are cylindrical in shape. Degaeta’s blanks are indeed roughly cylindrical in shape, but if a person of ordinary skill in the art thought to make balls for ball bearings out of Nitinol (absent any teaching whatsoever

in the art to do so), and attempted to use the process taught by Degaeta to make cylindrical ball blanks out of Nitinol wire, he would very quickly abandon the attempt when he found that Nitinol is so hard to shear in the wire chopper that his chopper blades needed replacement so often (after only a few cuts, if the Nitinol could be cut at all) that he would be unable to get anywhere near the production throughput to make an efficient process. But even if it were possible and technically feasible to make cylindrical Nitinol ball blanks in this way, it still would not fall within the scope of claim 14, which specifies (in parent claim 12) that the cylindrical ball blanks are cut from a sheet of material. Hence, claim 14 is patentable over the combination of Rouverol and Degaeta, independently of the patentability of claim 12.

Claim 15 calls for the ball blanks to be cut out of the sheet or plate by an industrial cutting laser. Neither Rouverol nor Degaeta disclose a single word about laser cutting, much less laser cutting out of a sheet of material. Applicant denies that laser cutting cubes out of a sheet of material would be obvious to a person of ordinary skill in the art in view of references that neither disclose laser cutting nor appear to have a need for laser cutting.

Claim 17 calls for tumbling the ball blanks in an abrasive tumbler to round off corners and edges of said ball blanks prior to grinding said ball blanks in said ball grinder. Degaeta does not disclose a tumbler. He discloses several tubular containers over a grinding disc. There is doubtless a degree of circulation of the ball blanks within the tubular containers, but it is not a conventional tumbler as Applicant disclosed, wherein the rounding of the cubes is accomplished by the action of the abrasive grinding media and the cubes tumbling against each other. Therefore, Degaeta does not disclose a process as defined in claim 17, so claim 17 should be patentable over the combination of Rouverol and Degaeta.

I. Claim 16 was rejected under 35 USC 103 as unpatentable over Rouverol and Degaeta in view of P/N 4,724,297 to Nielsen.

Claim 16, dependant on claim 12, calls for said ball blanks have a center and six equal orthogonal dimensions through said center.

Nielsen teaches a method of laser cutting metallic workpieces. Clearly, Nielsen teaches nothing about ball blanks. Applicant's response to the first Office Action suggested that the Examiner might have confused claims 15 and 16, since claim 15 does indeed claim the use of an industrial cutting laser to cut the ball blanks out of the sheet of material. However, the Examiner merely repeated the same rejection using the same words in his Final Office Action. Applicant is now confused as to exactly what the Examiner intended to do. Does he really intend to reject claim 16 using a reference that has nothing to do with the claim, or does he intend to reject claim 15 over that combination of references.

Assuming that the Examiner intended to reject claim 15 over the combination of Rouverol, Degaeta, and Nielsen, Applicant will address that assumed rejection. Nielson is cited as a teaching of the use of laser cutting and for the advantage of the absence of burrs. In fact, burrs are of no concern in the claimed process because the burrs grind off very easily and quickly in the abrasive tumbler. The real benefit of laser cutting is its speed and the very narrow kerf it makes, avoiding the waste of other processes (such as abrasive waterjet) that produce a somewhat wider kerf. However, current laser cutting apparatus is expensive, so these advantages are offset by the lower cost of waterjet cutting. In any case, the benefit cited by Nielson is of no consequence in Applicant's process. Moreover, Rouverol does not teach Nitinol rolling elements for ball bearings, and Nielsen does not teach that his laser cutting process will actually work to cut Nitinol sheet. Finally, it is known that Nitinol is adversely affected by even small amounts of absorbed oxygen, and Nielsen's process using oxygen in the gas could adversely affect the properties of the resulting Nitinol balls, especially since oxygen absorption is accelerated at higher temperature, such as the temperature in a laser kerf. If a person of ordinary skill in the art were to assemble the references that the Examiner has assembled and conceive of their use as the Examiner has proposed it (and Applicant very much doubts that a person of ordinary skill in the art would conceive of such a thing, as noted above) then this person of ordinary skill in the art would reject the use of Nielsen's laser because of the likelihood that the oxygen content of Nielsen's gas would be damaging to the desired properties of the Nitinol in the balls.

J. Claim 18 was rejected under 35 USC 103 as unpatentable over Rouverol in view of P/N 1,472,922 to Lothrop (and Sommer is also cited.)

Claim 18 calls for a process for making Nitinol bearing races, including selecting a tube made of Type 60 Nitinol. Rouverol does disclose a roller bearing in his Fig. 13 having rolling surface elements 135 and 135 made of shape-memory materials that can be prestressed. However, Rouverol does not specify Type 60 Nitinol, and does not disclose how such elements could be made.

Lothrop teaches a process of drilling a bar A of material to make a tube B. The tube is then cut off in the form of annular rings D. The rings are then placed in a die and upset to cause the material to flow and conform to the desired conical shape of the roller bearing race.

There is nothing in Rouverol or Lothrop that would teach a person of ordinary skill in the art how to select a tube made of Type 60 Nitinol. In fact, tubes of Type 60 Nitinol are not available anywhere in the world. Applicant has disclosed one process for making tubes of Type 60 Nitinol, but to Applicant's knowledge, there are no type 60 Nitinol tubes available to "select". Therefore, it would not be obvious to one skilled in the art to select a tube made of Type 60 Nitinol if such a tube is not available.

The process taught by Lothrop of drilling a bar of Type 60 Nitinol would not work. Type 60 Nitinol is nearly impossible to drill without the preparation taught by Applicant, and Type 60 Nitinol is not available in bar form. Thus, a person of ordinary skill in the art would not even begin to make the invention defined in claim 18 because the starter materials are not available and he would have no way of obtaining them. A person of ordinary skill in the art would not waste his time attempting to make something when the materials are not available, so the invention defined in claim 18 would be unobvious to a person of ordinary skill in the art.


Sommer teaches a method of centrifugal casting steel bearing races. Sommer does not teach making Nitinol races with the centrifugal casting process, or that Nitinol could be cast using that process, or any of the heat treating detail that are used to produce desirable properties in the resulting article. Thus, Applicant believes that Sommer is not an enabling teaching of the claimed process.

K. Claim 19 has been rejected under 35 USC 103 as obvious over Rouverol and Sommer in view of Stickels. Stickels teaches a process for heat-treating SAE 52,200 steel. Applicant asserts that the teaching would be known to a person of ordinary skill in the art to be applicable only to steel, and to SAE 52,200 steel in particular, and not to other materials, especially not to non-iron based materials. It is well known in the art of metallurgy that heat treating processes are specific to the specific material to be heat treated, and not to other materials. Surely the Examiner would not take the position that the Stickels process would apply to aluminum. It, like Nitinol, has no iron content. Thus, even if the Stickels heat treat process might be applicable to some other steel alloys, it a person skilled in the metallurgy art would not consider it to apply to non-ferrous metals. Thus, Stickels would not be regarded by a person of ordinary skill in the art to be an enabling teaching that would be applicable to Nitinol. Therefore, the combination of Rouverol, Sommer, and Stickels would not lead a person of ordinary skill in the art to make the invention claimed in claim 19.

Accordingly, Applicant believes that the remaining claims now pending in this Application after the R116 amendment are all patentable over the combinations of references cited by the Examiner and respectfully request that the Board reverse the Examiner's rejections and return this Application to him to issue this Application.

Respectfully submitted,

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9) Appendix

1-8. (Canceled)

9. (Previously Amended) A bearing for supporting a rotating shaft, comprising:
a multiplicity of rolling bearing elements radially positioned between said shaft
and a supporting structure;

wherein said rolling bearing elements include elements made of Type 60
Nitinol.

10. (Previously Amended) A bearing as defined in claim 9, wherein:
said rolling bearing elements include rods made of Type 60 Nitinol.

11. (Previously Amended) A process for making Nitinol rolling bearing elements
of a desired shape, comprising:

making a ceramic mold having a cavity with an internal shape like said desired
shape of said rolling bearing elements;

pouring molten Nitinol into said cavity;

cooling said mold and said Nitinol in said cavity to produce a solidified Nitinol
form;

disintegrating said mold to remove said Nitinol form;

heating said Nitinol form to an elevated temperature in a range of about 800°C-
950°C, and;

rotary forging said Nitinol form at said elevated temperature to produce a hot-
worked rod having a diameter slightly greater than the desired diameter of said rolling
bearing elements.

12. (Previously Amended) A process for making balls, comprising:
selecting a sheet or plate of Type 60 Nitinol;
cutting ball blanks out of said sheet or plate; and
grinding said ball blanks in a ball grinder to a desired spherical shape and size.

13. (Original) A process as defined in claims 12, wherein:
said ball blanks are cubical in shape.
14. (Original) A process as defined in claim 12, wherein:
said ball blanks are cylindrical in shape.
15. (Original) A process as defined in claim 12, wherein:
said ball blanks are cut out of said sheet or plate by an industrial cutting laser.
16. (Original) A process as defined in claim 12, wherein:
said ball blanks have a center and six equal orthogonal dimensions through
said center.
17. (Previously Amended) A process as defined in claim 16, further comprising:
tumbling said ball blanks in an abrasive tumbler to round off corners and edges
of said ball blanks prior to grinding said ball blanks in said ball grinder.
18. (Previously Amended) A process for making Nitinol bearing races,
comprising:
selecting a tube made of Type 60 Nitinol and having a central axis;
cutting bearing race blanks off said tube on a cutting plane perpendicular to
said central axis; and
grinding or machining said race blanks to desired outside dimensions and
interior configuration.
19. (Original) A process as defined in claim 18, further comprising:
heat treating said race blanks to about 900°C and quenching to produce
hardness of above about 58RC.

20. (Previously Amended) A rolling element bearing for supporting a rotating member, comprising:

a multiplicity of rolling bearing elements radially positioned between said member and a supporting structure; and

a bearing race including an annular ring of Type 60 Nitinol free of substantial compressive prestress.

21. (Previously Presented) A bearing as defined in claim 9, wherein:
said rolling bearing elements are spheres made of Type 60 Nitinol.